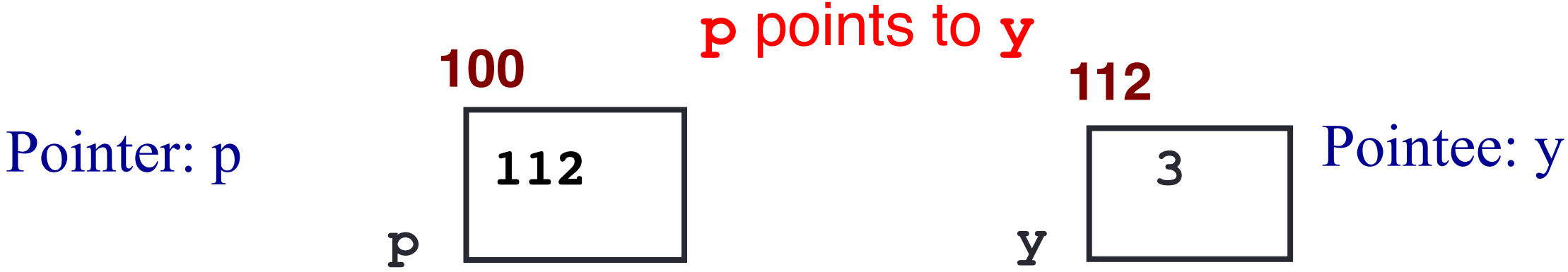
REFERENCES, POINTERS PASSING PARAMETERS TO FUNCTIONS

Problem Solving with Computers-I

Announcements

- H05 and H06 are released. (pdf versions available on website)
- Please submit a pdf version of your answers to the assignment on gradescope before the due date
  - Print, write by hand, scan, upload
  - Download, annotate, upload
  - Use Word (or some other text editor to write the answers only), convert to pdf and upload.

Pointer Diagrams:
Diagrams that show the relationship between pointers and pointees

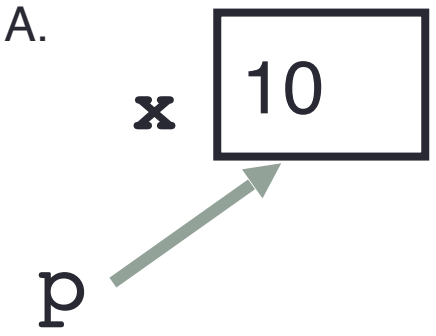


Tracing code involving pointers

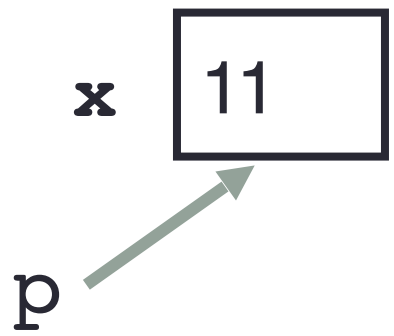
```
int *p;
int x = 10;
p = &x;
*p = *p + 1;
```

Q: Which of the following pointer diagrams best represents the outcome of the above code?

A.



B.



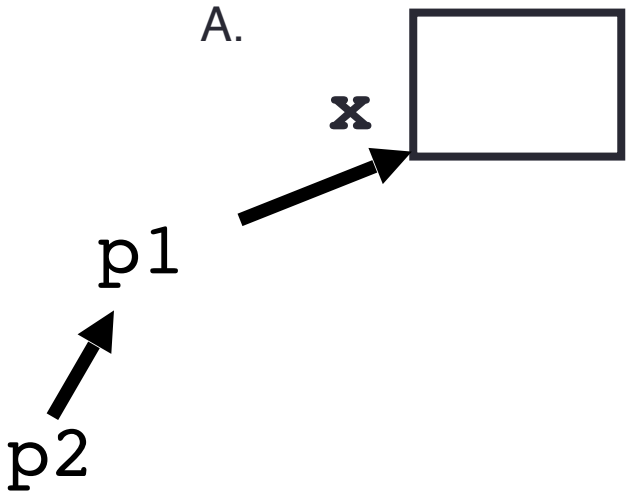
C. Neither, the code is incorrect

Pointer assignment

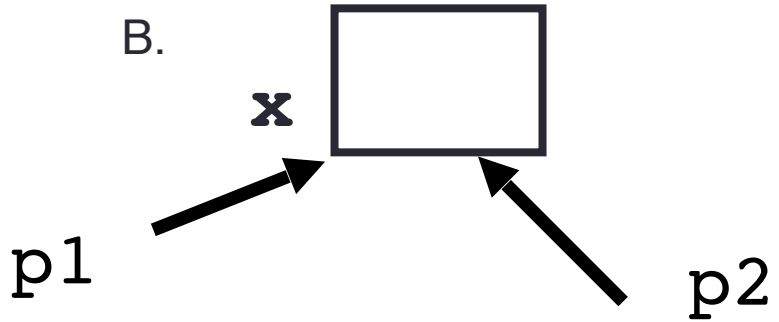
```
int *p1, *p2, x;
p1 = &x;
p2 = p1;
```

Q: Which of the following pointer diagrams best represents the outcome of the above code?

A.

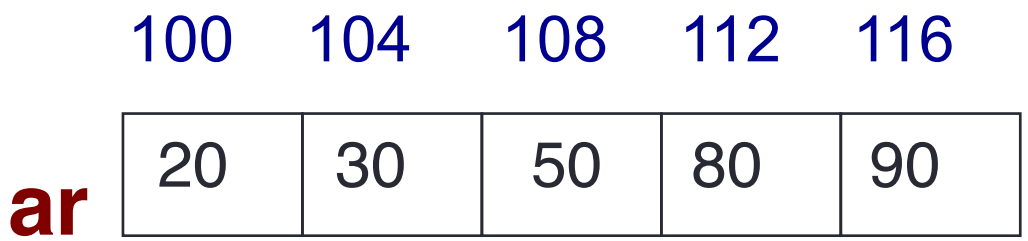


B.



C. Neither, the code is incorrect

Arrays and pointers



- `ar` is like a pointer to the first element
- `ar[0]` is the same as `*ar`
- `ar[2]` is the same as `*(ar+2)`

- Use pointers to pass arrays in functions
- Use *pointer arithmetic* to access arrays more conveniently

What is the output of the code?

```
char s1[] = "Mark";
char s2[] = "Jill";
for (int i = 0; i <= 4; i++)
      s2[i] = s1[i];
if (s1 == s2) s1 = "Art";
cout<<s1<<" "<<s2<<endl;
```

A. Mark Jill

B. Mark Mark

C. Art Mark

D. Compiler error

E. Run-time error

Pass by value

```
void swapValue(int x, int y){
     int tmp = x;
     x = y;
     y = tmp;
}
int main() {
     int a=30, b=40;
      cout<<a<<" "<<b<<endl;
     swapValue( a,  b);
     cout<<a<<" "<<b<<endl;
}
```

What is printed by this code?

A.

30 40

30 40

B.

30 40

40 30

C. Something else

References in C++

```
int main() {
   int d = 5;
   int &e = d;
}
```

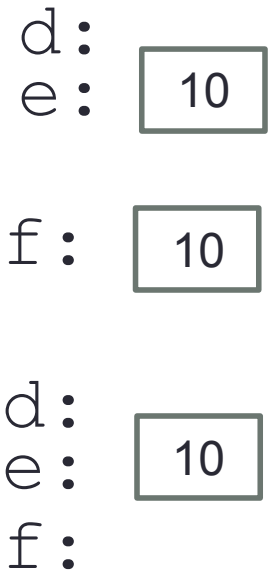
A reference in C++ is an alias for another variable

References in C++

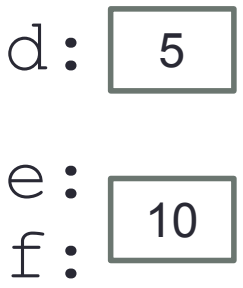
```
int main() {
   int d = 5;
   int &e = d;
   int f = 10;
   e = f;

}
```

How does the diagram change with this code?

A.



B.



C.

D. Other or error

Passing parameters by reference

```
void swapValue(int x, int y){
     int tmp = x;
     x = y;
     y = tmp;
}
int main() {
     int a=30, b=40;
     swapValue( a,  b);
     cout<<a<<" "<<b<<endl;
}
```

Passing parameters by address

```
void swapValue(int x, int y){
     int tmp = x;
     x = y;
     y = tmp;
}
int main() {
     int a=30, b=40;
     swapValue( a,  b);
     cout<<a<<" "<<b<<endl;
}
```

Pointer Arithmetic

- What if we have an array of large structs (objects)?
  - C++ takes care of it: In reality, `ptr+1` doesn't add `1` to the memory address, but rather adds the size of the array element.
  - C++ knows the size of the thing a pointer points to – every addition or subtraction moves that many bytes: 1 byte for a char, 4 bytes for an int, etc.

Pointer Arithmetic

```
int ar[]={20, 30, 50, 80, 90};
int *p;
p = arr;
p = p + 1;
*p = *p + 1;
```

Draw the array ar after the above code is executed

Pointer Arithmetic

```
int ar[]={20, 30, 50, 80, 90};
```

How many of the following are invalid?

I. pointer + integer (ptr+1)
II. integer + pointer (1+ptr)
III. pointer + pointer (ptr + ptr)
IV. pointer – integer (ptr – 1)
V. integer – pointer (1 – ptr)
VI. pointer – pointer (ptr – ptr)
VII. compare pointer to pointer (ptr == ptr)
VIII. compare pointer to integer (1 == ptr)
IX. compare pointer to 0 (ptr == 0)
X. compare pointer to NULL (ptr == NULL)

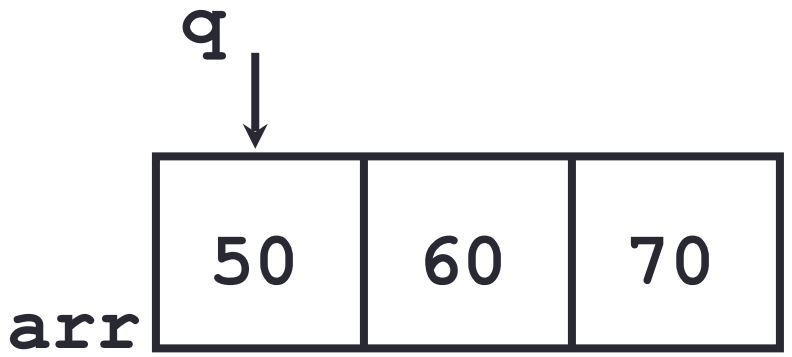
#invalid
A: 1
B: 2
C: 3
D: 4
E: 5

Pointers and references: Draw the diagram for this code

```
int a = 5;
int &b = a;
int *pt1 = &a;
```

What are three ways to change the value of ‘a’ to 42?

```
void IncrementPtr(int *p){
    p++;
}

int arr[3] = {50, 60, 70};
int *q = arr;
IncrementPtr(q);
```



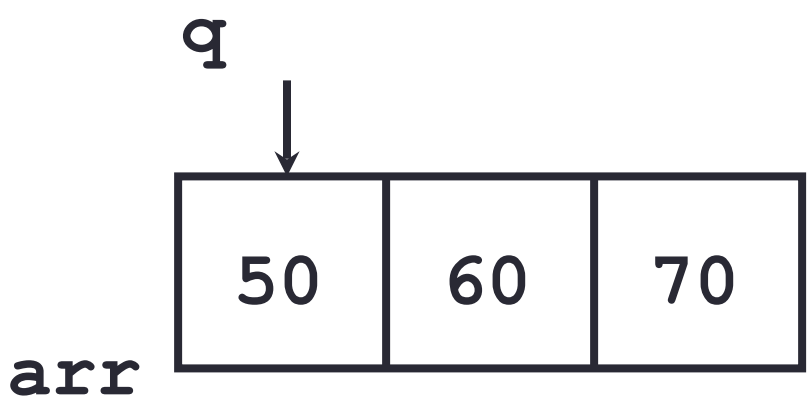
Which of the following is true after **`IncrementPtr(q)`** is called in the above code:

A. ‘q’ points to the next element in the array with value 60

B. ‘q’ points to the first element in the array with value 50

How should we implement `IncrementPtr()`, so that 'q' points to 60 when the following code executes?

```
void IncrementPtr(int **p){
    p++;
}

int arr[3] = {50, 60, 70};
int *q = arr;
IncrementPtr(&q);
```



A. `p = p + 1;`

B. `&p = &p + 1;`

C. `*p= *p + 1;`

D. `p= &p+1;`

Pointer pitfalls

- Dereferencing a pointer that does not point to anything results in undefined behavior.
- On most occasions your program will crash
- Segmentation faults: Program crashes because code tried to access memory location that either doesn’t exist or you don’t have access to

Two important facts about Pointers

1) A pointer can only point to one type –(basic or derived) such as `int`, `char`, a `struct`, another pointer, etc
2) After declaring a pointer: `int *ptr;`

   `ptr` doesn't actually point to anything yet.

   We can either:

   - make it point to something that already exists, OR
   - allocate room in memory for something new that it will point to

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   `ptr` doesn't actually point to anything yet.

   We can either:

   - make it point to something that already exists, OR
   - allocate room in memory for something new that it will point to
   - Null check before dereferencing

Next time

- Structs
- Arrays of structs